

Claims

1. An SOFC PEN with a cathode, said cathode comprising a porous cathode layer (cpc) and an active cathode layer (cac), with an anode, said anode comprising an active anode layer (caa), an anode support layer (csa, csa1, csa2), said anode support layer constituting the mechanical support of the PEN, and with at least one electrolyte layer (e), said electrolyte layer being placed between said active anode and cathode layers, characterized in that said anode comprises an anode collector layer (cca, cca1, cca2) which covers the rear face of the anode support layer, and in that the anode collector layer presents, on its rear face which is designed to come into contact with an interconnecting plate (i), a raised structure which is chosen so as to form gas circulation channels with said interconnecting plate.

2. The SOFC PEN as claimed in claim 1, characterized in that the cathode also has, on its rear face which is designed to come into contact with an interconnecting plate (i), a raised structure which is chosen so as to form gas circulation channels with said interconnecting plate, and in that the raised structures of the anode and of the cathode each comprise a plurality of prominent bumps (6) which are spaced apart from one another, the summit surfaces of the bumps of the anode being substantially coplanar and parallel to the summit surfaces of the bumps of the cathode, the latter likewise being coplanar with one another.

3. The SOFC PEN as claimed in claim 2, characterized in that it comprises at least one first hole (1) and at least one second hole (2) passing axially through it, in that the raised structure of the rear face of the anode comprises at least one first lip (3) that surrounds said first hole, and in that the raised structure of the rear face of the cathode comprises at least one second lip that surrounds said second hole, said first hole not being surrounded by a said second lip and said second hole not being surrounded by a said first lip.

4. The SOFC PEN as claimed in claim 3, characterized in that the raised structures of the respective rear faces of the cathode and anode each comprise an edging (4) that surrounds each rear face, each capable of forming, in collaboration with an interconnecting plate, a chamber that is sealed except on an open portion (5) of said edging.

5. The SOFC PEN as claimed in claim 3, characterized in that it comprises at least four axial holes and in that the raised structures of the rear faces of the anode and cathode each have an edging that respectively surrounds said rear faces, and at least one inlet hole (7, 9) and one outlet hole (8, 10) for each of the fuel and oxidizing gases respectively.

6. The SOFC PEN as claimed in any of the preceding claims, characterized in that the front face of the anode on the electrolyte side also has a raised structure.

7. The SOFC PEN as claimed in claim 6, characterized in that the anode support layer (csa) has a raised structure on its front face, in that the active anode layer (caa), the electrolyte (e) and the cathode (cac, cpc) consist of thin layers which cover said raised structure of said front face, and in that the raised structure of said front face of the anode support layer is chosen so that the rear face of the cathode can form gas circulation channels with an interconnecting plate with which it comes into contact.

8. The SOFC PEN as claimed in claim 7, characterized in that the structure of the front face of the anode support layer is obtained by a molding process and in that the thin layers are obtained by a deposition process.

9. The SOFC PEN as claimed in either of claims 7 and 8, characterized in that said raised structure of the front face of the anode comprises a plurality of bumps having a height of

between 0.2 and 2 mm, and in that the distance between the flanks of neighboring bumps is between 0.1 and 2 mm.

10. The SOFC PEN as claimed in claim 6, characterized in that the anode support layer (csa) has an anterior raised structure on its front face, in that the active anode layer (caa), the electrolyte (e) and the active cathode layer (cac) consist of thin layers, and in that the porous cathode layer (cpc) has, on its rear face which is designed to come into contact with an interconnecting plate, a raised structure which is chosen so as to form gas circulation channels with said interconnecting plate.

11. The SOFC PEN as claimed in claim 10, characterized in that said anterior raised structure of the front face of the anode support layer is obtained by stamping.

12. The SOFC PEN as claimed in claim 10, characterized in that said anterior raised structure of the front face of the anode support layer is obtained by a micromolding process.

13. The SOFC PEN as claimed in claim 12, characterized in that said anterior raised structure of the front face of the anode support layer is obtained by micromolding and gelling.

14. The SOFC PEN as claimed in any of claims 10 to 13, characterized in that the height of the raised elements of said anterior raised structure is between 0.1 and 2 mm and in that the distance between neighboring elements is between 50  $\mu$ m and 2 mm.

15. The SOFC PEN as claimed in any of claims 6 to 14, characterized in that the ratio between the height and the thickness of the elements of the raised structure of the front face of the anode is between 1 and 4.

16. The SOFC PEN as claimed in any of claims 6 to 15, characterized in that the anode is obtained by joining the smooth rear face of the anode support layer to the smooth front face of the anode collector layer.

17. The SOFC PEN as claimed in any of the preceding claims, characterized in that the raised structures of the front faces and/or rear faces of the anode and cathode are obtained by molding, in particular by micromolding and gelling.

18. The SOFC PEN as claimed in any of claims 1 to 17, characterized in that the material of the anode support layer and/or anode collector layer comprises fibers selected from ceramic fibers and metal fibers.

19. The SOFC PEN as claimed in claim 18, characterized in that the proportion of said fibers is from 20 to 40% by volume, and in particular from 25 to 35% with respect to the total volume.

20. The SOFC PEN as claimed in any of claims 1 to 19, characterized in that the material of the porous cathode layer comprises fibers selected from ceramic fibers, in particular LSM fibers and LSC fibers.

21. The SOFC PEN as claimed in any of claims 18 to 20, characterized in that the diameter (d) of said fibers is between 1 and 50  $\mu\text{m}$  and the ratio  $L/d$  is between 2 and 30, in particular in that said diameter is between 2 and 30  $\mu\text{m}$  and the ratio  $L/d$  is between 5 and 25, more particularly in that the diameter is between 5 and 15  $\mu\text{m}$  and the ratio  $L/d$  is between 8 and 20.

22. The SOFC PEN as claimed in any of claims 1 to 21, characterized in that the material of the anode support layer and/or anode collector layer comprises a reforming catalyst selected from Ni deposited on ceramic particles, NiCu

deposited on ceramic particles, chromites,  $\text{CeO}_2$ , and mixtures thereof.

23. The SOFC PEN as claimed claim 22, characterized in that the amount of catalyst is between 5 and 15% by volume of the material of the anode.

24. An SOFC stack, comprising a plurality of PENs as claimed in any of claims 3 to 22 and interconnecting plates, in an alternating manner, characterized in that each of said interconnecting plates is a smooth and planar plate provided with holes that are coincident with the holes of the PENs, as seen in the stacking axis.